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William Lassell, Esq., F.R.S., President, in the Chair.

John Brett, Esq., 6 Pump Court, Temple;
Rev. Reginald F. Dale, M.A., Queen's College, Oxford; and
Rev. Archibald Robertson, Burrage Road, Plumstead,

were balloted for, and duly elected Fellows of the Society.

The Variations of Gravity in the Western Provinces of Russia.

By A. Sawitsch. (Abstract.)

A great arc of the meridian having been measured in Russia with all the precision which modern methods of observation will admit of, it became an interesting subject to examine the variations of the intensity of gravity in the districts traversed by this arc, and to compare the progress of those changes with the variations which are observed in the direction of gravity determined at several stations by astronomical observations and geodetical operations. An extensive series of pendulum observations was therefore arranged by the Academy of Sciences of St. Petersburg, to be made at certain stations between Tornea in Finland, and Ismail in Moldavia, selecting only those points of which the geographical positions and elevations above the mean level of the sea were determined in connexion with the great arc of meridian. The observations between Tornea and St. Petersburg were made during the summer of 1865 by M. Sawitsch and M. Lenz; those between St. Petersburg and Ismail were made in 1866 and 1868 by M. Sawitsch and M. Smyslof.

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Two reversible pendulums were placed at the service of the observers. They were constructed by M. Repsold, of Hamburg. The pendulums differed from the English instruments both in their dimensions and in the arrangements of some of their parts. During the experiments, the clock and its tripod were inclosed in a case so that currents of air had no effect on the oscillations of the pendulum. A standard scale for the examination of the distance between the two knife-edges was also constructed by M. Repsold, and verified by M. Smyslof by comparison with the normal standard constructed by Messrs. Troughton and Simms, now deposited at the Observatory of Pulkowa.

M. Brauer, of St. Petersburg, furnished an apparatus for determining the centre of gravity of the pendulum, and also for the examinations of the parallelism of the knife-edges. M. Sawitsch remarks that these pendulums have now been placed at the disposal of Colonel Walker, Superintendent of the Great Trigonometrical Survey of India.

The observation of the duration of the oscillations of the pendulum consisted in noting the time of the coincidences of the pendulum and clock, the daily rate of the latter being deduced from comparisons of it with chronometers. A transit-instrument was erected on a brick pier, and the daily rate of the chronometers determined from transits of stars. Three or four coincidences and the temperature were observed at the beginning, in the middle, and at the end of each "swing." Three thermometers were placed in the interior of the pendulum-case, one at the upper end, another near the centre, and the third at the bottom end of the pendulum. The barometer was read at the beginning and end of each "swing."

M. Sawitsch gives in detail the formulæ used by him in the reductions, and also the results of the observations, which are given for twelve different stations situated between 65° 51′ and 45° 20′ north latitude. At St. Petersburg the length of the seconds' pendulum found directly from the observations is 440·958 Paris lines, the latitude being 59° 56′ 30″.

"Our object was not so much to determine the absolute length of the pendulum as to collect new data on the variations of gravity, and to compare them with those which have been found at other stations on the terrestrial surface. We know that at London the length of the simple seconds' pendulum has been determined with great precision by Capt. Kater and by General Sir E. Sabine; and that the measures made in Great Britain by M. Biot agree perfectly with those obtained by the English *savants*, while those made in France by the English *savants* give the same results as those of M. Biot. To these determinations we may also add the observations made by travellers and naval officers in different parts of the world. To connect our experiments with the preceding system of researches, without a breaking of continuity, we prefer not to adopt our direct determination of the length of the pendulum at St. Petersburg,

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but rather that which was deduced from the oscillations of a similar invariable pendulum, observed by M. le Comte Luetke at St. Petersburg and at the Royal Observatory at Greenwich; the difference between the length of the seconds' pendulum at Greenwich and London having been accurately determined by Sir E. Sabine. Thus the length of the simple seconds' pendulum being known at London, we can calculate its length at St. Petersburg according to the relation of the squares of the numbers of infinitely small oscillations which the comparison pendulum, reduced to the same temperature *in vacuo*, has made at each of the stations in a mean day. In this manner, the calculation gives for the length of the simple seconds' pendulum at St. Petersburg 39·16975 English inches, or 441·0319 Paris lines. Assuming this length, we have deduced, as the result of our observations, the values contained in the following table."

Place of Observation.	Latitude N. ° ′ ″	Longitude E. from Greenwich. h m s	Length of the Seconds' Pendulum in Paris lines.
Tornea	65 50 43	1 36 54	441·2525
Nicolaistadt	63 5 33	1 26 26	441·1293
St. Petersburg	59 56 30	2 1 14	441·0319
Réval	59 26 37	1 39 1	441·0190
Dorpat	58 22 47	1 46 54	440·9762
Jacobstadt	56 30 3	1 43 4	440·8900
Wilna	54 41 2	1 41 12	440·8353
Bélin	52 2 22	1 40 52	440·7268
Kréménetz	50 6 8	1 42 54	440·6533
Kaménetz-Podolsk	48 4 39	1 46 18	440·5844
Kischinef	47 1 30	1 55 18	440·5278
Ismail	45 20 34	1 55 16	440·4479

To examine the accuracy of each of the results, M. Sawitsch has compared the length of the pendulum observed at each station with the corresponding length obtained from the formulæ given in his paper. The residual errors are as follows: the sign + denoting that the observed length is greater than the calculated length.

	Paris Lines.		Paris Lines.
Tornea	+0·0200	Wilna	−0·0001
Nicolaistadt	−0·0141	Bélin	−0·0035
St. Petersburg	−0·0017	Kréménetz	+0·0017
Réval	+0·0033	Kaménetz-Podolsk	+0·0160
Dorpat	−0·0002	Kischinef	+0·0030
Jacobstadt	−0·0157	Ismail	−0·0071

The sum of the positive residual errors is +0·0440, and of the negative residual errors −0·0423.

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Thus the formula agrees well with the equations of condition. With regard to individual errors, they depend upon errors of observation and upon anomalies in the intensities of terrestrial gravity; but it is difficult to discover in the differences given above any certain traces of these anomalies and of the local causes which produce them.

"In the work of W. Struve on the arc of meridian between the Danube and the Arctic Sea is a detailed discussion of the latitudes of the principal places between the North Cape and the Danube. The differences in latitude found directly from the astronomical observations vary only ± 1″·75 from those deduced from the geodetical operations. Although these differences are very much larger than the errors of observation, they are not as great as those which may be found in corresponding operations in other countries. Our stations are in the neighbourhood of the places discussed by M. Struve; so that it appears that in the great plains of Western Russia the directions and intensities of gravity are not subject to anomalies which change sensibly from one of our stations to another."

On the Physical Changes in Jupiter. By A. C. Ranyard, Esq.

It was suggested at one of the recent meetings of the Society, that if *Jupiter* had at any time been studied with sufficient optical power the same details would always have been apparent, and it was hinted that much which individual observers had been disposed to record as changes occurring upon the surface of *Jupiter*, was really to be attributed to the increased power of the instruments used.

In answer to such objections I propose to compare a small series of drawings, all made within the last twenty years, by well-known observers and with large instruments.

We will commence with a drawing by Mr. Lassell, a very poor woodcut from which is given at page 134 of vol. x. of the *Monthly Notices*. It was taken with his 20-feet reflector and 24 inches aperture. *Jupiter* is there represented within two years of the great Sun-spot maximum of 1848, and the strongly-marked white spots in the southern belts, and the broken condition of the equatorial region, are very apparent.

Within a year of the next Sun-spot minimum Mr. W. De La Rue made his large and well-known drawing of *Jupiter* with a 13-inch silver speculum. Its date is October 1856, and his engraving, which was largely circulated, was at that time universally acknowledged to be a very just representation of the state of the planet. It is full of the smallest details in the belts, yet there are no traces to be found of Dawes' markings, bright points, northern or southern eggs, or equatorial port-holes.

A second drawing, made in 1856 by Piazzi Smyth on *Teneriffe* with a 7¼-inch refractor, when *Jupiter* was near the zenith,